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(54) Title: METHOD FOR LEAK DETECTION IN A PIPELINE SYSTEM

(57) Abstract

Method for leak detection in a pipeline system, more particularly in a water supply and sewer system. The purpose of the invention is to efficiently and with great accuracy determine the scope and location of damages in the line system. For this purpose leakage indicating means are employed that comprise tracers, which are supplied to the water running through the pipes, each pipe being supplied a special tracer. Samples are taken at certain points downstream in the system. These samples are analysed and the concentration of tracers is determined. Using the concentration figures, the inflow of tracers from adjacent pipes can be established, in respective pipes. Thus, an estimation of the leakage from and to each pipe can be made.

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# METHOD FOR LEAK DETECTION IN A PIPELINE SYSTEM

The present invention concerns a method for leak detection in a pipeline system, preferably in a water supply and sewer system, in the following called the line system.

It is of economic importance that the water supply and sewerage in a society is continuously restored and maintained. Besides the fact that costs for the renewal of sections of the pipelines, and for repair of broken pipe segments, are high, there is another problem that can bring about large expenses, namely dilution of the waste water through in-leakage into the waste water pipe from the surface water pipe in the line system, or the in-leakage of other irrelevant water, for instance ground water or pure water. Due to this dilution the capacity load at the sewage treatment plant will be heavier, since the volume of incoming water to be purified increases, which leads to a more costly operation.

Another factor of importance from an environmental viewpoint is if the surface water, which normally is let out into a recipient without being purified, is blended with the waste water, which means an undesirable load on the environment.

In order to be able to carry out measures for the restoration and management of the water supply and sewer system for the purpose of preventing or eliminating the above problems or the like, good knowledge is required about the condition of the line system. Such a study should be implemented at several sub levels. At the first level the line system is classified into "malfunctioning" and "functioning" parts. This analysis will bring about a composite picture of present damages in the system. Areas, which are considered in need of further examination and analysis, are selected so that, at a second sub level, the bad pipeline sections can be narrowed down block by block. Finally, at a third sub level, the scanning is specified down to the measurement of meters, whereby the size and range of the damage is exactly determined.

Examinations of this kind has so far been done by means of the TV technique. A TV camera has been lowered down into the pipeline system for the direct observation of possible leaks. By this method, however, one can establish only larger leaks where the water streams in more definably at one point. It has not been possible to exactly locate minor leaks through which the water trickles. An additional drawback with this technique is that a normal operation of the line system not is possible during the search. In some cases for instance, the pipe that is to be tested has to be turned off, or the fluid of the pipe has to be led past the stretch of pipe that is to be scrutinized.

One object of the method according to the invention is to make it possible to determine or estimate the amount of irrelevant inflow into the line system, and to allow the determination of the interaction between the pipes in the line system, that is, a leakage from one pipe to the other. Irrelevant inflow is here understood for instance as the inflow of pure water or ground water. A further object is to allow an examination of the line system without the interruption or disturbance of the normal operation.

It is previously known how to perform a leak detection of individual pipes of different types, for instance water or gas pipes, by the admission of radioactive tracers (DE-A-1 279 382), by the admission of substances which at a leak react with air and render a visible reaction product (published patent application SE-7 203 486-1), by the admission of substances that can be detected by an infrared detector (ibid), or by the admission of freon (published patent application SE-7 613 291-9) that can be detected by a leak detector of a prior art construction.

The idea of the present invention is, by supplying different tracers into each pipe of the line networks and by determining the concentrations of these tracers at points downstream, to estimate the inflow of irrelevant water, and the interaction

between the pipes, that is, the water inflow into respective pipes from the other pipes due to a leakage.

Since this interaction can be determined, it is possible, contrary to previous technique, to establish also a leakage from a pipe. Thereby an additional estimate of the size of the leak is obtained, since the concentration of tracers is related to the flow through the leak.

In the following the invention will be more closely clarified by means of an example in the form of a leak search in a line system. For a person skilled in the art it is however evident that the invention is applicable also to other types of pipeline systems. This example of an embodiment is not meant to confine the invention.

The method according to the invention is carried out at three levels. The object of the method of the first level is a rough mapping of which areas within the system require a closer analysis. Thus, peripherally in the line system the surface water pipe is supplied with a certain amount of water, when there is a prevalent need thereof. This is meant to correspond to an occasion when the filling degree is high in the surface water pipe, as it would be, for example after a downpour. At suitable wells downstream, the surface water pipe and waste water pipe are supplied with different leakage indicating means either during a longer period of time, with the concentration and flow being constant, or in batches. This supply is activated by an automatic and adjustable dosing feeder, preferably a dosage pump.

The leakage indicating means comprises tracers which have to be what is called water true. This means that the substances are not allowed to be adsorbed on the walls of the pipes, neither bonded to those materials or substances that are dissolved or suspended in the water, streaming through the pipes. Of course, the substances being part of the leakage indicating means must not, by being corrosive, affect the line

system. On selecting substances one should also take into consideration various environmental aspects, such as the effect on sensitive recipients such as lakes, creeks and other water ways, as well as the biological step in water purifying plants, where the active micro organisms can be inactivated by toxic substances.

After the admission of tracers the system is allowed to achieve the balance, so that the concentrations of the tracers are no longer being altered by the time factor. When equilibrium is attained samples are taken in a well downstream, adjacent to the outlet of a larger collecting pipe. These samples undergo a chemical and/or physical analysis for determining the concentrations of respective tracers. Samples are taken at different points corresponding to occasions with a low and high production, respectively, of waste water. The sampling can be carried out by means of any known sampler, or by simply lowering the cord of a sample bottle into the well, whereby the bottle is filled up and then hoisted.

At the second level, on one hand one determines the interaction between the waste water and surface water pipe, in sections between consecutive wells, and on the other hand the inflow is estimated regarding irrelevant water (pure water, ground water) flowing to the waste water pipe between consecutive wells. This is in principle being carried out as at the first level, that is, periferally in the line system, the surface water pipe is supplied with a certain amount of water, when there is a need thereof, which intendedly corresponds to an occasion when the filling degree is high in the surface water pipe, as for example after a downpour. Leakage indicating means is supplied to the surface water pipe and waste water pipe at suitable wells downstream relative to the wells where the water was supplied, during a longer period of time and with constancy in concentration and flow. This supply occurs automatically by means of an adjustable dosing feeder, preferably a dosage pump. The leakage indicating

means are the same as before. Samples are then taken in wells situated downstream, in the same way as at the first level, for determining the tracer concentration.

When calculating the flow in the pipes, the following relation is employed;

$c_0 \times q = c_1 \times Q$, where

$c_0$ = concentration of a supplied tracer
$q$ = flow of tracers
$c_1$ = concentration of a tracer at one sampling point
$Q$ = flow in the water waste pipe.

$c_0$ and $q$ are known, while $c_1$ is determined by an analysis and, thus, $Q$ can be calculated.

Setting off from the measured values, Q can be calculated at the different points downstream of the line system, after which an estimation of the leakage and admixing of the surface water into the waste water pipe and vice versa, can be carried out. At the same time thorough flow determinations at the sampling points are obtained, for calculating the in-leakage of other irrelevant water (for instance pure and ground water) into the waste water pipe, between the sampling points. The calculation is done in such a way that for each part of the pipeline stretch, between two sampling points, the increase of waste water in the pipe is determined by ways of a difference calculation, setting the increase in relation to the number of working branches. The increase of flow per working branch calculated in this way is set in relation to the rest of the line system. Thereafter an estimation is made of the probability of irrelevant water in the wast water pipe for the concerned stretch of the pipeline.

At the third level a minute examination is performed of individual pipeline stretches in the length of meters, where a leakage has been established by means of the above methods.

The method is in principle the same as for level two, except for a difference in the sampling method. For an accurate determination of the occurrence of an in-leakage, samples are taken in the pipe between two consecutive wells. The sampling is carried out in such a way that a wire is drawn between the wells. On the wire there is a hose attached, onto which a negative pressure pump is connected. The wire and the hose are provided with measurement markings, so that one can read at what distance from the well a sample is taken. Thus, samples can be taken, employing this method, at an optional point along the pipe between two wells.

CLAIMS

1. Method for leak detection in a pipeline system and more particularly in a water supply and sewer system, wherein a leakage indicating means is supplied to the fluid in the system, c h a r a c t e r i z e d in that one of the pipes in the line system, at a first point in an area that is to be examined, is supplied a certain amount of fluid, if there is a need thereof, that, at a second point downstream in the line system relative to said first point, each of the system pipes is supplied different leakage indicating means, either during a longer period of time the concentration and flow being constant, or in batches, and that, at one of the points in each pipe, samples are taken for determining the concentration of the leakage indicating means, whereby the interaction between the system pipes is determined by ascertaining the in-leakage of a tracer into the pipe said tracer deriving from another pipe.

2. Method according to claim 1, c h a r a c t e r i z e d in that samples are taken at several consecutive points, downstream relative to the first point, for determining the concentration of the leakage indicating means.

3. Method according to claim 1 or 2, c h a r a c - t e r i z e d in that a number of samples are taken in a pipe between two adjacent sampling points in the same pipe by means of a hose connected to a pump and being drawn through the pipe between said adjacent points in the pipe, whereby samples are taken at optional points, which points are determined from measurement markings on the hose, or on a separate measuring tape.

4. Method according to any of preceding claims, c h a r a c- t e r i z e d in that the supplied fluid is constant and plentiful in relation to the normal flow through the pipe.

5. Method according to any of the preceding claims

c h a r a c t e r i z e d in that the concentration of the leakage indicating means is determined in the chemical and/or physical analysis the interaction between the pipes being ascertained by the showing of an in-leakage into the pipe of tracers deriving from other pipes.

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# INTERNATIONAL SEARCH REPORT

International Application No PCT/SE85/00526

## I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC4

G 01 M 3/22

## II. FIELDS SEARCHED

**Minimum Documentation Searched [7]**

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|---|---|
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| Nat Cl | 42k:30/02-/04 |
| US Cl | 73:40.5, 40.7, 49.1 |

**Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]**

SE, NO, DK, FI classes as above

## III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

| Category * | Citation of Document, [11] with indication, where appropriate, of the relevant passages [12] | Relevant to Claim No. [13] |
|---|---|---|
| Y | US, A, 4 328 700 (FRIES) 11 May 1982 & JP, 53115287 | 1, 2, 4, 5 |
| Y | US, A, 1 693 737 (W.B. WELDON) 4 December 1928 | 1, 2, 4, 5 |

* Special categories of cited documents: [10]

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## IV. CERTIFICATION

| Date of the Actual Completion of the International Search | Date of Mailing of this International Search Report |
|---|---|
| 1986-02-14 | 1986 -03- 03 |
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